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# MARK SCHEME for the October/November 2015 series

## 9701 CHEMISTRY

**9701/21** Paper 2 (AS Structured Questions), maximum raw mark 60

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| Question | Mark Scheme | Mark | Total |
|---|---|---|---|
| 1 (a) | regular arrangement / lattice of cations / positive ions<br>surrounded by delocalised electrons | [1]<br>[1] | [2] |
| (b) (i) | electrical conductor<br>corrosion resistant<br>low density<br>ductile owtte | [1]<br>[1] | [max2] |
| (ii) | Giant / lattice | [1] | [1] |
| (iii) | (electrical) insulator | [1] | [1] |
| (c) (i) | Simple covalent / covalent molecule<br><br>Weak intermolecular forces / VdW forces<br>OR<br>little energy needed to break down / overcome intermolecular / VdW forces | [1]<br><br>[1] | [2] |
| (ii) | $\frac{Al}{20.3}$ $\frac{Cl}{79.7}$<br>$27$ $35.5$<br><br>$\frac{0.752}{0.752}$ $\frac{2.25}{0.752}$<br><br>1 3 $AlCl_3$ | [1]<br><br>[1] | [2] |

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|---|---|---|---|
| (iii) | $pV = \frac{m}{M_r}RT$ $\quad M_r = \frac{mRT}{pV}$ $\quad = \frac{1.36 \times 8.31 \times 473}{100 \times 10^3 \times 200 \times 10^{-6}}$<br>$= 267$<br><br>**OR** $pV = nRT$ $\quad n = \frac{pV}{RT}$ $\quad = \frac{100 \times 10^3 \times 200 \times 10^{-6}}{8.31 \times 473}$<br>$= 5.09 \times 10^{-3}$<br><br>$M_r = \frac{1.36}{5.09 \times 10^{-3}} = 267$ | [1]<br>[1]<br><br>[1]<br><br>[1] | [2] |
| (iv) | $Al_2Cl_6$ | [1] | [1] |
| | | | **[13]** |
| 2 (a) (i) | The enthalpy change when one mole of a compound<br>is formed from its element(s) | [1]<br>[1] | [2] |
| (ii) | $S(s) + 1½O_2(g) \rightarrow SO_3(l)$ | [1] | [1] |
| (b) (i) | $944 + (3 \times 436) = 2252$<br>$6 \times 390 = 2340$<br>$2252 - 2340 = -88\,(kJ\,mol^{-1})$ | [1]<br>[1]<br>[1] | [3] |
| (ii) | Fe catalyst<br>200 atm<br>400–500 (°)C | [1]<br>[1]<br>[1] | [3] |
| (iii) | High T increases rate AND Low T improves yield owtte<br>Chosen temp is a compromise<br>High P favours / increases (both rate and) yield owtte<br>pressure chosen limited by cost (of compression and 'thick walls') | [1]<br>[1]<br>[1]<br>[1] | [4] |

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| (c) (i) | $2NH_3 + H_3PO_4 \rightarrow (NH_4)_2HPO_4$ | [1] | [1] |
| (ii) | $NH_3$ identified as base AND $H_3PO_4$ identified as acid<br>base accepts protons AND acid donates protons | [1]<br>[1] | [2] |
| (d) (i) | nitrates / fertilisers wash into rivers<br>eutrophication / algal bloom / promote algal growth<br>bacteria use up oxygen in decay process | [1]<br>[1]<br>[1] | [3] |
| (ii) | (oxides of nitrogen / $NO_x$ / NOs) cause acid rain<br><br>$2NO_2 + H_2O \rightarrow HNO_2 + HNO_3$<br>OR<br>$4NO_2 + 2H_2O + O_2 \rightarrow 4HNO_3$<br>OR<br>$SO_2 + NO_2 \rightarrow SO_3 + NO$ AND $SO_3 + H_2O \rightarrow H_2SO_4$ | [1]<br><br>[1] | [2] |
| | | | **[21]** |
| 3 (a) (i) | structural isomers: (different molecules with) same molecular formula<br>but different structural formulae<br><br>chiral: has a carbon / C attached to 4 different groups / atoms / chains OR has no plane / line of symmetry / has non-superimposable mirror images | [1]<br><br>[1] | [2] |
| (ii) | $CH_3CH_2CH(CH_3)CH_2CH_2CH_3$<br>3-methylhexane<br><br>$CH_3CH(CH_3)CH(CH_3)CH_2CH_3$ / $(CH_3)_2CHCH(CH_3)CH_2CH_3$<br>2,3-dimethylpentane | [1]<br>[1]<br><br>[1]<br>[1] | [4] |
| (b) (i) | $C_7H_{16} + 11O_2 \rightarrow 7CO_2 + 8H_2O$ | [1] | [1] |
| (ii) | $C_7H_{16} + 4O_2 \rightarrow 7C + 8H_2O$ | [1] | [1] |

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|---|---|---|---|
| (iii) | global dimming / PAN / smog / global warming | [1] | [1] |
| (c) (i) | (Free) Radical Substitution | [1] | [1] |
| (ii) | $Cl_2 \rightarrow 2Cl\bullet$<br>OR<br>$Cl_2 \rightarrow Cl\bullet + Cl\bullet$<br><br>$C_7H_{16} + Cl\bullet \rightarrow \bullet C_7H_{15} + HCl$<br>$\bullet C_7H_{15} + Cl_2 \rightarrow C_7H_{15}Cl + Cl\bullet$<br><br>$\bullet C_7H_{15} + Cl\bullet \rightarrow C_7H_{15}Cl$ OR $\bullet C_7H_{15} + \bullet C_7H_{15} \rightarrow C_{14}H_{30}$<br><br>Initiation; Propagation; Termination (used correctly) | [1]<br><br>[1]<br>[1]<br><br>[1]<br><br>[1] | [5] |
| | | | **[15]** |
| **4** (a) (i) | $CH_3CH_2OH + HCl \rightarrow CH_3CH_2Cl + H_2O$<br>or<br>$CH_3CH_2OH + PCl_5 \rightarrow CH_3CH_2Cl + HCl + POCl_3$<br>or<br>$CH_3CH_2OH + SOCl_2 \rightarrow CH_3CH_2Cl + HCl + SO_2$ | [1+1] | [2] |
| (ii) | NaOH / KOH<br>warm / heat / reflux AND aqueous | [1]<br>[1] | [2] |
| (b) (i) | $CH_2{=}CH_2$ / ethane / $C_2H_4$ / $CH_2CH_2$ | [1] | [1] |
| (ii) | White ppt / solid / suspension | [1] | [1] |
| (iii) | $Ag^+(aq) + Cl^-(aq) \rightarrow AgCl(s)$ | [1] | [1] |
| (c) (i) | $CH_3CHO$ / ethanal | [1] | [1] |

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| (ii) | $CH_3CH_2OH$ higher bpt than $CH_3CHO$ ora | [1] | |
| | due to hydrogen bonding in ethanol / stronger IMFs | [1] | [3] |
| | prevents further oxidation owtte | [1] | |
| | | | **[11]** |

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